THE **FISHERIES IMPROVED FOR SUSTAINABLE HARVEST PROJECT**

ESTIMATION PROCEDURE OF FISH PROJECT RESULT (FPR)

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LIST OF ABBREVIATIONS AND ACRONYMS

APR	Focal Area Project Result
BAP	Baseline Assessment Plan
CPUE	Catch per Unit of Effort
FISH	Fisheries Improved for Sustainable Harvest
FPR	FISH Project Result
IR	Intermediate Result
MPA	Marine Protected Area
PMP	Performance Monitoring Plan
Tetra Tech	Tetra Tech EM Inc.
USAID	United States Agency for International Development

Estimation Procedure of FISH Project Result (FPR)[1]

1. Introduction

The main objective of the FISH Project is to conserve biological diversity in the four selected focal areas through improved management of the fish stocks and fish habitats that support them. When not addressed, the problem of excessive and destructive fishing can lead to decline in catch rates, decline in fish yields, and loss of biodiversity. Putting in place or improving fisheries resource management practices in the four focal areas is tantamount to effecting change in behavior from destructive fish and habitat exploitation practices to more sustainable resource use and exploitation patterns.

The main project objective will be measured in terms of change in the marine fish stocks from 2004 to 2010. The objective is to increase abundance of marine fish stocks by at least 10 percent over this period. The single measure of the 10 percent increment will be based on three Project Results or PRs. This document is supplement to the FISH Performance Monitoring Plan (PMP) and the Baseline Assessment Plan (BAP) and explains the detailed computational process and steps to pool and average the three PRs. It also shows how the parameters measured in each PR are combined using weighting factors to determine the overall FISH project result or FPR.

The FPR and PR1, PR2 and PR3 as defined in the FISH BAP are repeated below for clarity.

FPR:	Marine fish stocks increased by 10% (over 2004 baseline levels) in focal areas by year 2010.

PR1:	Abundance of selected fisheries resources in focal areas (% change in catch per unit effort compared to baseline based on fishery-independent methods)
PR2:	Catch rate of selected fisheries in focal areas (% change in catch per unit effort compared to baseline based on fishery-dependent methods)
PR3:	Reef fish and biomass inside and adjacent to selected MPAs in focal areas (% change in biomass/500 m^2 compared to baseline)

The FISH PMP and BAP detail the entire results framework for the FISH Project. These documents explain the Intermediate Results (IR) and their respective sub-IRs that measure the various governance and technical processes required to effect human behavioral changes that in-turn drive the protection and enhancement of marine fish stocks (to be measured in the PRs and ultimately the FPR).

It is emphasized that the FISH Project's main objective (increase in marine fish stocks by 10 percent) is to be achieved on top of the current downward national trend in stock densities, catch rates, and fish habitat quality. This means that before the 10 percent increment can be achieved the downward trend needs first to be arrested. It also means that simply maintaining the current stock densities will require a large portion of project investment and

[1] This document that explains the estimation of the FISH Project Result is a supplement to the FISH Performance Monitoring Plan and should be considered as an annex to that document.

can already be considered a positive result of fisheries resource management interventions. Figure 1 depicts the overall trend in demersal biomass decline in the Philippines and contrasts this to potential increases that the FISH Project is striving to accomplish.

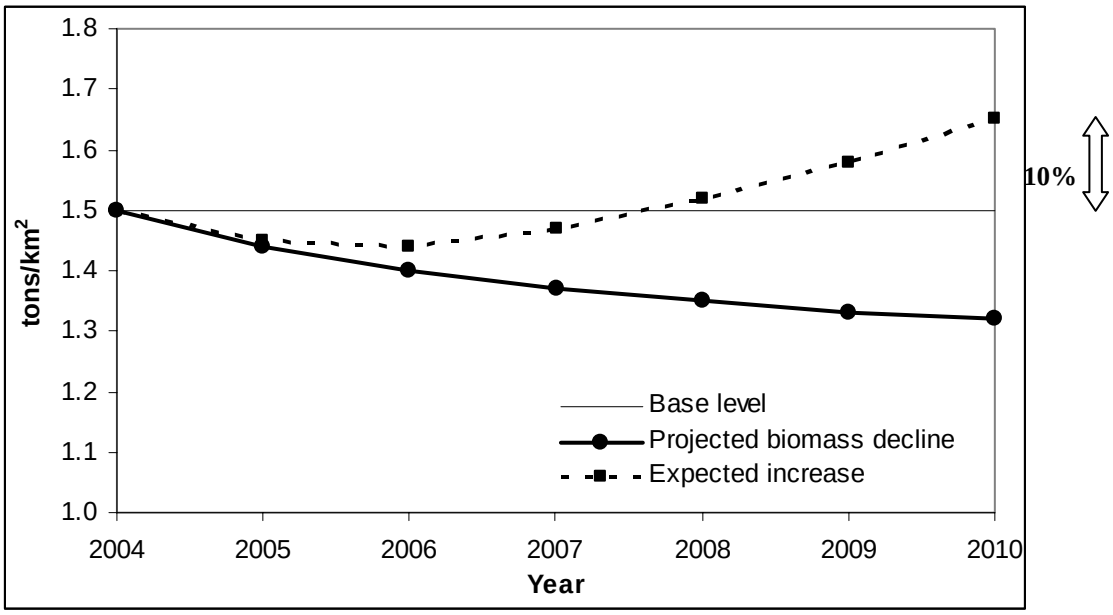


Figure 1. Trend of Philippine demersal biomass decline and the Fish Project result

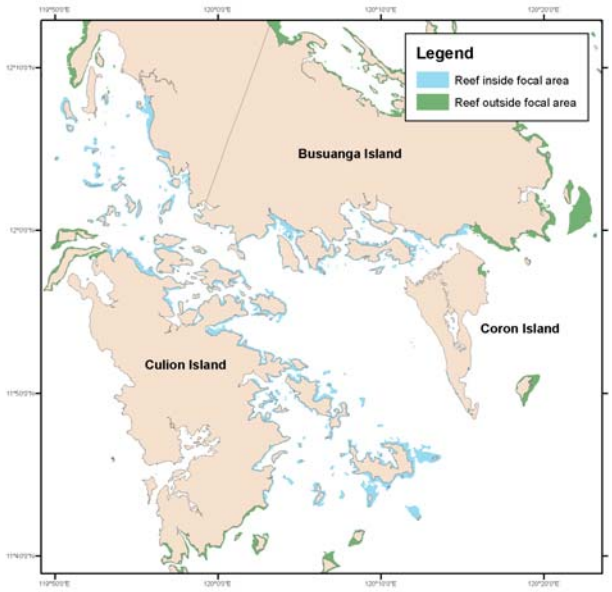
2. Rationale, Logic, and Principles in Determining the FPR

The principles and assumptions that guide the overall estimation of the FISH PRs are listed and explained below. These are based on the best knowledge and research to date concerning fisheries management in general, the base line assessments conducted for FISH, as well as the available and relevant information from the focal areas of FISH. The approach effectively grounds the determination of the FPR directly to the realities of geographical size of the focal areas, the relative area of different habitat types in the focal areas that directly affect potential fish yields, the potential fish yields based on empirical data from various studies in the Philippines as well as the relative quality (variance) of the data sets collected for the measurement of PRs 1, 2, and 3. The approach also maximizes the value of the relative efforts of the FISH Project to influence the management of fisheries through a variety of interventions including marine protected areas in the shallower coral reef and sea-grass areas. A detailed explanation follows.

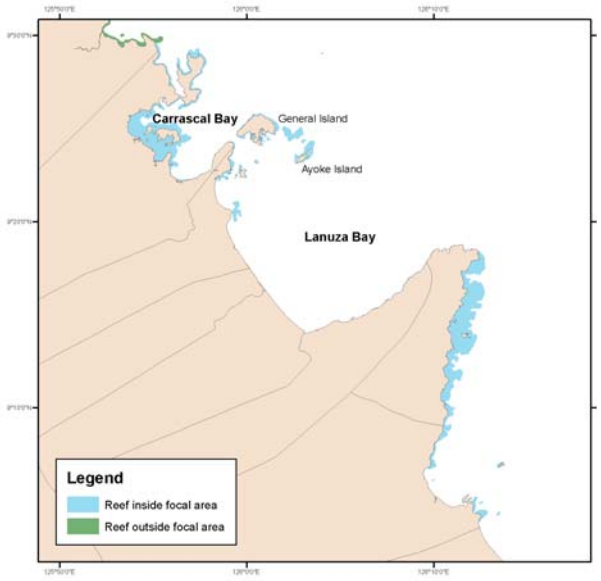
1. **The overall FPR will be measured as percent change from the 2004 baseline**. It will be the difference between Project Results (PR1, PR2, and PR3) measured in year 2004 and year 2010 expressed as percentage change compared to baseline assessment conducted in year 2004.

2. **The FPR will be a pooled value of Project Results from each focal area (APR_C, APR_D, APR_L and APR_T) using the estimated surface area of the focal area as a weighting**

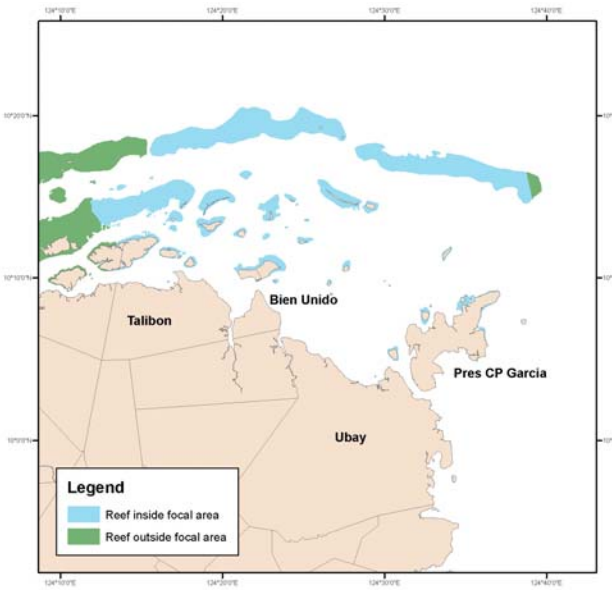
factor (C = Coron Bay, D = Danajon Bank, L = Lanuza Bay, T = Tawi-Tawi Bay). Thus, the total surface area of each focal area will determine the relative importance of the measured results from each of the four focal areas. The logic is that the area covered represents the relative effort or difficulty by the project to accomplish a result, as well as the relative contribution to improved fisheries management from a total project perspective. Figure 2 shows the four focal areas and their relative area of coverage.



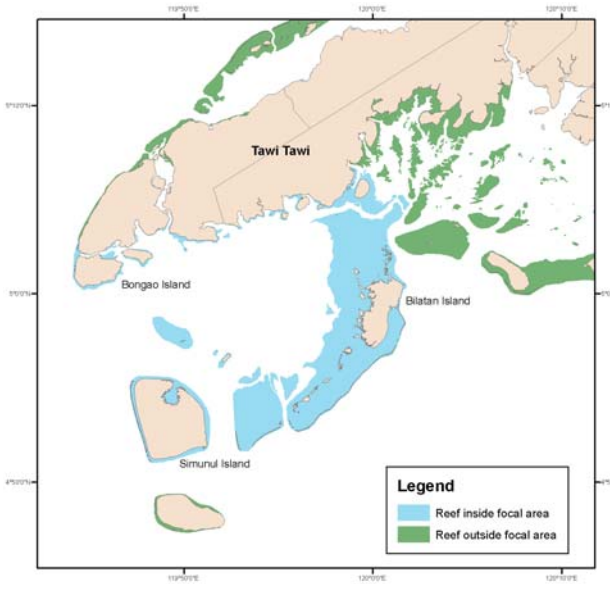
Calamianes Focal Area



Lanuza Bay Focal Area



Danajon Bank Focal Area



TawiTawi Focal Area

Figure 2. The Focal Areas of the FISH Project with Coral Reef Area Highlighted

3. **The focal area Project Result (APR_C, APR_D, APR_L or APR_T) will be measured to represent progress made in each target area**. This is explained in the BAP and as agreed with USAID is the most practical way to effect and measure changes in fish stock given the relatively large size of the entire target areas and the resources available to the FISH Project.

4. **Each focal area Project Result (APR_C, APR_D, APR_L or APR_T) will be a pooled value consisting of independent estimates of PR1, PR2, and PR3 in every focal area using various weighting factors**. Thus each PR within each focal area will be determined based on independent data collected during the baseline assessment (2004) and repeated monitoring of the fishery determinants of the PR (2006, 2008, and 2010). The three PRs will then be pooled to determine the focal area PR. The pooling will be accomplished as further explained below using a weighting factor for each PR to determine its contribution to the focal area APR. Once the three PRs for a given focal area are pooled, the four focal area APRs will be pooled according to the area coverage of the focal area of concern.

5. **PR1 will be measured through test fishing methods using selected fishing gears used in the focal area.** The manner that this is done is explained in the BAP and is distinguished by being independent of the actual fishery activities in the area.

6. **PR2 will be measured through catch and effort monitoring of commonly used gears in the focal area.** The manner this is accomplished is as explained in the BAP and is distinguished by utilizing data from common fishing practices in the area.

7. **PR3 will be measured through fish visual census inside and adjacent to selected marine protected areas (MPAs) in the focal area.** This is explained in the BAP using standard and accepted protocols.

8. **Potential yield[2] estimates from the various components of the resource system will be used as the main basis for determining and establishing the weighting factor for PR1, PR2, and PR3 in the focal area**. In this manner, the relative importance of the three PRs within a given focal area will be determined by the area of the bottom habitat type expanded by the potential yield of that particular bottom habitat type. The two habitat types considered are "soft/hard bottom" (affecting PR1 and PR2 for demersal and pelagic fisheries) and "coral reefs" (affecting PR3 for reef fisheries) in which the coral reefs include all common reef associated communities such as sea grasses, shallow sand and others commonly present in reef areas and occur at depths of less than 20 meters. The areas of the two bottom habitat types are given in Table 1.

9. **Number of samples will be the basis for determining the weighting factor for each component PR1 and PR2 and the area of project established MPAs for PR3 in the focal area**. Thus each component will be weighted according to the number of runs, number of transects, number of catch sampled, and area of MPA. The idea is

[2] Standing stock estimates may be used in lieu of potential yield in this weighting process. Potential yield is used here given that it is more readily available in the literature.

to give proportional emphasis or weight to components in relation to the number of replicates made and project investment.

3. Detailed Explanation of Procedures and Determination of Weighting Factors Used

The overall FPR will be computed as the difference between Project Results (PR1, PR2, and PR3) measured in year 2010 and year 2004 expressed as percentage change compared to baseline assessment conducted in year 2004. The overall FPR will be the weighted average of the focal area Project Results (APR_C, APR_D, APR_L or APR_T) using the estimated surface area of the respective focal area (Table 1) as the weighting factor:

$$FPR = \frac{(APR_C \cdot w_C) + (APR_D \cdot w_D) + (APR_L \cdot w_L) + (APR_T \cdot w_T)}{w_C + w_D + w_L + w_T}$$

where: FPR = Overall FISH Project Result
APR_C = Area Project Result for Coron Bay
APR_D = Area Project Result for Danajon Bank
APR_L = Area Project Result for Lanuza Bay
APR_T = Area Project Result for Tawi-Tawi Bay
w_C = weighting factor for Coron Bay (estimated surface area of the focal area)
w_D = weighting factor for Danajon Bank (estimated surface area of the focal area)
w_L = weighting factor for Lanuza Bay (estimated surface area of the focal area)
w_T = weighting factor for Tawi-Tawi Bay (estimated surface area of the focal area)

Table 1. Estimates of surface areas of soft bottom, hard bottom, and coral reefs (and associated communities) in the four focal areas*.

Focal area	Surface area (km^2)		
	Soft/hard bottom	Coral reefs	Total
Coron Bay	760	100	860
Danajon Bank	1,030	198	1,227
Lanuza Bay	1,249	81	1,330
Tawi-Tawi Bay	265	177	442

* All estimates are yet to be finalized as remote sensed images are being digitized to determine the exact areas for the two major habitat bottom types

The focal area Project Result (APR_{fa}) will be represented by measurements from the focal area. Each focal area Project Result (APR_C, APR_D, APR_L or APR_T) will be a pooled value consisting of independent estimates of PR1, PR2, and PR3 in every focal area using various weighting factors:

$$APR_{fa} = \frac{(PR1 \cdot w_{PR1}) + ((PR2 \cdot w_{PR2}) + (PR3 \cdot w_{PR3})}{w_{PR1} + w_{PR2} + w_{PR3}}$$

where: APR_{fa} = Project Result for the focal area

fa = focal area

$PR1$ = Project Result estimated using fishery-independent survey methods

$PR2$ = Project Result estimated using fishery-dependent survey methods

$PR3$ = Project Result estimated using fish visual census inside and outside MPAs

w_{PR1} = weighting factor for PR1

w_{PR2} = weighting factor for PR2

w_{PR3} = weighting factor for PR3

PR1 is measured as the change in the catch per unit of effort (CPUE) of surveys using fisheries-independent methods:

$$PR1 = \frac{\overline{CPUE}_{PR1,2010} - \overline{CPUE}_{PR1,2004}}{\overline{CPUE}_{PR1,2004}} \times 100$$

where: $PR1$ = Project Result estimated using fishery-independent survey methods in a particular focal area

$\overline{CPUE}_{PR1,2004}$ = Weighted average catch per unit effort of gears used in the fisheries-independent survey in the baseline year 2004

$\overline{CPUE}_{PR1,2010}$ = Weighted average catch per unit effort of gears used in the fisheries-independent survey in reckoning year 2010

100 = multiplier to express the result as percent change

The parameters used to measure PR1 are the weighted average of catch per unit effort of various fishing gears used during the test fishing with the number of replicates as the weighting factor:

$$\overline{CPUE}_{Year} = \frac{(CPUE_1 \cdot n_1) + (CPUE_2 \cdot n_2) + ... + (CPUE_n \cdot n_n)}{n_1 + n_2 + ... + n_n}$$

where: $\overline{CPUE}_{PR1,Year}$ = Weighted average catch per unit effort estimated using fishery-independent survey methods

$CPUE_1$ = Average catch per operation of 1st fishing gear type used in the survey

$CPUE_2$ = Average catch per operation of 2nd fishing gear type used in the survey

$CPUE_n$ = Average catch per operation of nth fishing gear type used in the survey

n_1 = number of replicates of the 1st fishing gear type used in the survey

n_2 = number of replicates of the 2nd fishing gear type used in the survey

n_n = number of replicates of the nth fishing gear type used in the survey

PR2 is measured as the change in the catch per unit of effort of surveys using fisheries-dependent methods:

$$PR2 = \frac{\overline{CPUE}_{PR2,2010} - \overline{CPUE}_{PR2,2004}}{\overline{CPUE}_{PR2,2004}} \times 100$$

where: $PR2$ = Project Result estimated using fishery-independent survey methods
$\overline{CPUE}_{PR2,2004}$ = Weighted average catch per unit effort of gears used in the fisheries-dependent survey in the baseline year 2004
$\overline{CPUE}_{PR2,2010}$ = Weighted average catch per unit effort of gears used in the fisheries-dependent survey in reckoning year 2010
100 = multiplier to express the result as percent change

The parameters used to measure PR2 are the weighted average of catch per unit effort of various fishing gears used during the 3-month catch and effort monitoring using the number of samples as weighing factor:

$$\overline{CPUE}_{PR2,Year} = \frac{(CPUE_1 \cdot n_1) + (CPUE_2 \cdot n_2) + ... + (CPUE_n \cdot n_n)}{n_1 + n_2 + ... + n_n}$$

where: $\overline{CPUE}_{PR2,Year}$ = Weighted average catch per unit effort estimated using fishery-dependent survey methods
$CPUE_1$ = Average catch per operation of 1st fishing gear type monitored
$CPUE_2$ = Average catch per operation of 2nd fishing gear type monitored
$CPUE_n$ = Average catch per operation of nth fishing gear type monitored
n_1 = number of samples of the 1st fishing gear type monitored
n_2 = number of samples of the 2nd fishing gear type monitored
n_n = number of samples of the nth fishing gear type monitored

PR3 is measured as the change in the biomass (in tons/km^2) through fish visual census inside and adjacent to selected MPAs in focal the areas:

$$PR3 = \frac{\overline{B}_{PR3,2010} - \overline{B}_{PR3,2004}}{\overline{B}_{PR3,2004}} \times 100$$

where: $PR3$ = Project Result estimated using fish visual census methods
$\overline{B}_{PR3,2004}$ = Weighted average of fish biomass inside and adjacent to MPAs estimated through fish visual census in the baseline year 2004
$\overline{B}_{PR3,2010}$ = Weighted average of fish biomass inside and adjacent to MPAs estimated through fish visual census in reckoning year 2010
100 = multiplier to express the result as percent change

The parameters used to measure PR3 are the weighted average of biomass (in tons/km^2) determined through fish visual census inside and adjacent to selected MPAs in the focal areas using the area of the MPAs as weighting factor:

$$\overline{B}_{Year} = \frac{(B_1 \cdot a_1) + (B_2 \cdot a_2) + ... + (B_n \cdot a_n)}{a_1 + a_2 + ... + a_n}$$

where: $\bar{B}_{Year}$ = Weighted average of fish biomass estimated using fish visual census inside and adjacent to MPAs

B_1 = Average biomass estimated inside and adjacent to the 1st MPA

B_2 = Average biomass estimated inside and adjacent to the 2nd MPA

B_n = Average biomass estimated inside and adjacent to the nth MPA

a_1 = area of the 1st MPA

a_2 = area of the 2nd MPA

a_n = area of the nth MPA

The weighting factor for PR1 is the product of the potential yield of a demersal habitat (Table 2) and the area covered by both the hard and soft bottom (Table 1). Only the potential yield of the demersal habitat was used since the fisheries-independent surveys conducted were limited only to demersal fisheries. This is based on the assumption that demersal fish stocks are less subject to annual fluctuation compared to their pelagic counterpart. Hard and soft bottoms were not segregated because there are no reliable geological and hydrographic data to serve as reference.

$$w_{PR1} = \frac{(PY_{dem}) \cdot (A_{hs})}{2}$$

where: w_{PR1} = weighing factor for PR1

PY_{dem} = Potential yield (t/km^2/yr) for the demersal stock

A_{hs} = Area (km^2) of hard and soft bottom

2 = this divisor is needed, since both weighting factors cover the same area, to avoid double counting.

The weighting factor for PR2, on the other hand, is defined as the product of collective potential yields of demersal and pelagic stocks (Table 2) and the area covered by the hard and soft bottom substrates (Table 1). The potential yields of both the demersal and pelagic stocks were used since catch and effort of both demersal and pelagic fisheries were monitored. And similarly, hard and soft bottoms were not segregated because there are no reliable geological and hydrographic data to serve as reference.

$$w_{PR2} = \frac{(PY_{dem} + PY_{pel}) \cdot (A_{hs})}{2}$$

where: w_{PR2} = weighting factor for PR2

PY_{dem} = Potential yield (t/km^2/yr) for the demersal stock

PY_{pel} = Potential yield (t/km^2/yr) for the pelagic stock

A_{hs} = Area (km^2) of hard and soft bottom

2 = This divisor is needed, since both weighting factors cover the same area, to avoid double counting.

The weighting factor for PR3 is the product of the potential yield of coral reef ecosystem (Table 2) and the extent of the coral reef in each focal area (Table 1). Only the area of the coral reef was used as basis since all MPA initiatives of the FISH Project are focused on coral reef ecosystems and their associated communities such as sea grass beds. The value may increase once habitat protection initiatives are likewise initiated in other fish

habitat systems like mangrove forests. Increasing this area and value will mean decreasing the hard and soft bottom areas and values. The approach is rational and captures the initiatives the FISH Project is investing in its efforts to establish and make MPAs effective in the target areas.

$$w_{PR3} = PY_{cor} \cdot A_{cor}$$

where: w_{PR3} = weighting factor for PR3
PY_{cor} = Potential yield (t/km^2/yr) for the coral reef
A_{cor} = Area (km^2) of coral reef

Table 2. Estimates of annual potential harvest (t/km^2) of various marine habitats in the Philippines

Bottom type and depth	Estimated annual average harvest	Source
0-200 meters	3.50 t/km^2 (demersal species)	Kvaran, 1971
0-200 meters	3.25 t/km^2 (in-shore pelagic species)	Kvaran, 1971
200 meters and deeper	0.20 t/km^2 (off-shore pelagic species	Kvaran, 1971
Reef area	15.6 t/km^2 (all fishes)	White & Trinidad 1998; Russ 1991. Alcala & Gomez 1985
Estuary	17.0 t/km^2 (all fishes)	Pauly, 1982

4. Results and Implications of the 2004 Baseline Assessment in FISH Focal Areas

Baseline assessment was conducted in the four focal areas in 2004. The assessment work consisted of test fishing activities using selected fishing gears commonly used in the focal areas, catch and effort monitoring of commonly used gears in the focal areas, and fish visual census inside and adjacent to selected MPAs in the focal area. Results from these surveys will not only be used for establishing the baseline but will also form part of the FISH Project's fisheries profiling activities. Ultimately, this will become part of the information system to be used for fisheries resource management planning in the target areas

4.1. Surveys Conducted

Fishery-Independent Surveys (to determine PR1)

Results of fishery-independent surveys in the four focal areas are summarized in Table 3. Only one fishery-independent test fishing activity (bottom-set longline) was conducted in Coron Bay. The FISH Project will improve this by conducting bottom-set gillnet survey in year 2005. Similarly, bottom-set gillnet survey will also be initiated in Danajon Bank so that all the four focal areas will have two fishing gears in common in their respective fishery-independent surveys.

Fishery-Dependent Surveys (to determine PR2)

Results of fishery-dependent surveys are given in Tables 4a, 4b, 4c, and 4d. Only gears that were sampled more than 100 times during the three-month catch and effort monitoring activities were considered. This is meant more or less to reduce the variance (standard deviation and standard error). Catch and effort of commercial fishing gears and illegal fishing methods operating in the focal areas were likewise monitored but were excluded from the computations. The assumption is that these fishing gears will no longer be in operation in the focal areas once the FISH Project's fisheries resource management initiatives are in place. As mentioned earlier, through the introduction or improvement of fisheries resource management the project hopes to trigger changes in fish exploitation patterns from destructive to sustainable ones.

Table 3. Results of fishery-independent surveys in the four focal areas with their corresponding cpue (in kg/setting), standard deviation and number of settings

Focal area	Fishing gear used	Major specification	Mean	s	n
Coron Bay	Bottom-set longline	800 hooks #565 & #563	7.06	3.20	33
Danajon Bank	Bottom-set longline	1000 hooks #566	4.77	3.03	30
Danajon Bank	Baby trawl	hr: 11.1m, fr: 8.9 m, 65hp	4.54	6.04	19
Danajon Bank	Fish trap	10 pots	1.06	0.68	30
Lanuza Bay	Bottom-set longline	800 hooks #562	4.87	3.63	30
Lanuza Bay	Bottom-set gillnet	6 panels ms 6, 7 & 8	2.12	3.08	22
Tawi-Tawi Bay	Bottom-set longline	200 hooks #17 & #18	3.71	2.89	69
Tawi-Tawi Bay	Bottom-set gillnet	12 panels ms7 & ms8	5.86	3.20	24
Tawi-Tawi Bay	Fish trap	10 pots	5.48	3.58	23

Table 4a. Results of catch and effort monitoring in Coron Bay

Fishing gear	Variation	Mean	s	n
Gill net	Bottom set gillnet	9.0	19.1	452
Gill net	Drift gillnet	21.5	17.4	146
Hook and line	Bottom set longline	11.0	18.1	142
Hook and line	Multiple handline	12.5	17.7	291
Hook and line	Simple hook and line	5.6	11.5	529

Table 4b. Results of catch and effort monitoring in Danajon Bank

Fishing gear	Variation	Mean	s	n
Crab liftnet	Crab liftnet	3.4	1.6	703
*Danish seine	*Danish seine	24.9	15.7	360
Fish corral	Fish corral	5.4	4.6	115
Gill net	Bottom set gillnet	15.7	21.4	136
Gill net	Crab gillnet	3.4	2.2	703
Gill net	Drift gillnet	7.4	6.7	425
Gill net	Drive-in gillnet	14.7	10.1	204
Gill net	Set gillnet with plunger	10.3	6.5	228
Hook and line	Bottom set longline	4.5	3.1	210
Hook and line	Simple hook and line	2.5	1.8	351
Pot	Crab pot	6.7	2.4	449
*Trawl	*Otter trawl	13.7	6.6	164

* Illegal fishing gears; not included in estimation of PR2

Table 4c. Results of catch and effort monitoring in Lanuza Bay

Fishing gear	Variation	Mean	s	n
Gill net	Bottom set gillnet	4.9	4.9	447
Gill net	Drift gillnet	11.7	9.2	264
Hook and line	Bottom set longline	9.0	8.8	472
Hook and line	Simple hook and line	4.3	4.5	191
Jig	Octopus jig	3.5	1.9	584
Jig	Squid jig	3.9	2.4	90
Spear	Handspear	6.3	4.4	245

Table 4d. Results of catch and effort monitoring in Tawi-Tawi Bay

Fishing gear	Variation	Mean	s	n
*Dynamite	*Dynamite	54.1	76.0	263
Gill net	Drift gillnet	55.9	38.7	156
Gill net	Surface set gillnet	29.3	18.7	425
Hook and line	Bottom set longline	15.6	11.1	209
Hook and line	Multiple handline	19.6	14.3	134
Hook and line	Troll line	29.6	30.2	113
Jig	Octopus jig	3.5	2.8	142
*Ring net	*Ring net	307.6	445.2	93
Spear	Spear gun	5.2	8.0	124
Spear	Spear with compressor	37.6	27.0	103

* Illegal fishing gears; not included in estimation of PR2

Biomass surveys inside and outside MPAs (to determine PR3)

Results of fish biomass surveys in selected proposed MPAs in the four focal areas using fish visual census are given in Table 5.

Table 5. Estimates of fish biomass (t/km^2) inside and outside MPAs in the four focal areas.

Focal Area	Designation	Location	Area of MPA (km^2)	Estimated biomass (tons/km^2)
Coron Bay	MPA_1	Lajala (Uson Island)	0.60	10.97
	MPA_2	Sangat-Decalve (Apo-Sangat)	0.64	21.99
	MPA_3	Bugor Island	0.96	29.84
Danajon Bank	MPA_1	Guindakpan Island	0.46	12.90
	MPA_2	Bilangbilangan East Island	0.45	25.90
	MPA_3	Hingutanan East Island	0.22	42.90
	MPA_4	Bantigue Island	0.19	19.50
Lanuza Bay	MPA_1	Carrascal	1.12	11.55
	MPA_2	General Island	0.31	15.20
	MPA_3	Auqui Island	0.25	13.75
Tawi-Tawi Bay	MPA_1	Pababag Island, Bongao	0.20	9.70
	MPA_2	Batu-Batu, Panglima Sugala	0.20	19.88
	MPA_3	Simunul	0.20	25.97

4.2. Estimation of the PR of Each Respective Focal Area

PRs for Coron Bay, Danajon Bank, Lanuza Bay, and Tawi-Tawi Bay will be computed individually starting with the estimates of PR1, PR2, and PR3; their respective weighting factors, w_{PR1} , w_{PR2} , and w_{PR3} ; and finally the APR for the area.

Coron Bay

$$\overline{CPUE}_{PR1,2004} = \frac{(7.06)(33)}{33} = 7.06$$

$$\overline{CPUE}_{PR2,2004} = \frac{(9.0)(452)+(21.5)(146)+(11.0)(142)+(12.5)(291)+(5.6)(529)}{452+146+142+291+529} = 9.85$$

$$\overline{B}_{PR3,2004} = \frac{(10.97)(0.60)+(21.99)(0.64)+(29.84)(0.96)}{0.60+0.64+0.96} = 22.41$$

$$w_{PR1} = 3.50 \cdot \frac{(3.50)(760)}{2} = 1{,}330.00$$

$$w_{PR2} = \frac{(3.50+3.25)(760)}{2} = 2{,}565.00$$

$$w_{PR3} = (15.60)(100) = 1{,}560.00$$

If in 2008 the estimates for the surveys were: $\overline{CPUE}_{PR1,2010} = 8.00$, $\overline{CPUE}_{PR2,2010} = 10.81$, and $\overline{B}_{PR3,2010} = 24.89$, the Project Results for Coron Bay will be:

$$PR1 = \frac{8.00 - 7.06}{7.06} \times 100 = 13.31\%$$

$$PR2 = \frac{10.81 - 9.85}{9.85} \times 100 = 9.76\%$$

$$PR3 = \frac{24.89 - 22.41}{22.41} \times 100 = 11.07\%$$

$$APR_C = \frac{(13.31)(1{,}330.00) + (9.76)(2{,}565.00) + (11.07)(1{,}560.00)}{1{,}330 + 2{,}565 + 1{,}560} = 11.00\%$$

Danajon Bank

$$\overline{CPUE}_{PR1,2004} = \frac{(4.77)(30) + (4.54)(19) + (1.06)(30)}{33 + 19 + 30} = 3.31$$

$$\overline{CPUE}_{PR2,2004} = \frac{(3.4)(703) + (5.4)(115) + (15.7)(136) + (3.4)(703) + (7.4)(425) + (14.7)(204) + (10.3)(228) + (4.5)(210) + (2.5)(351) + (6.7)(449)}{703 + 115 + 136 + 703 + 425 + 204 + 228 + 210 + 351 + 449} = 5.92$$

$$\overline{B}_{PR3,2004} = \frac{(12.9)(0.46) + (25.9)(0.45) + (42.9)(0.22) + (19.5)(0.19)}{0.46 + 0.45 + 0.22 + 0.19} = 23.28$$

$$w_{PR1} = \frac{(3.50)(1{,}030)}{2} = 1{,}802.50$$

$$w_{PR2} = \frac{(3.50 + 3.25)(1{,}030)}{2} = 3{,}476.25$$

$$w_{PR3} = (15.60)(198) = 3{,}088.80$$

If in 2008 the estimates for the surveys were: $\overline{CPUE}_{PR1,2010} = 5.72$, $\overline{CPUE}_{PR2,2010} = 6.28$, and $\overline{B}_{PR3,2010} = 25.40$, the Project Results for Danajon Bank will be:

$$PR1 = \frac{5.72 - 3.31}{3.31} \times 100 = 73.07\%$$

$$PR2 = \frac{6.28 - 5.92}{5.92} \times 100 = 6.06\%$$

$$PR3 = \frac{25.40 - 23.28}{23.28} \times 100 = 9.10\%$$

$$APR_D = \frac{(73.07)(1{,}802.50) + (6.06)(3{,}476.25) + (9.10)(2{,}970.00)}{1{,}802.50 + 3{,}476.25 + 3{,}088.80} = 21.62\%$$

Lanuza Bay

$$\overline{CPUE}_{PR1,2004} = \frac{(4.87)(30)+(2.12)(22)}{30+22} = 3.71$$

$$\overline{CPUE}_{PR2,2004} = \frac{(4.9)(447)+(11.7)(264)+(9.0)(472)+(4.3)(191)+(3.5)(584)+(3.9)(90)+(6.3)(245)}{447+264+472+191+584+90+245} = 6.23$$

$$\overline{B}_{PR3,2004} = \frac{(11.55)(1.12)+(15.2)(0.31)+(13.75)(0.25)}{1.12+0.31+0.25} = 12.55$$

$$w_{PR1} = \frac{(3.50)(1{,}249)}{2} = 2{,}185.75$$

$$w_{PR2} = \frac{(3.50+3.25)(1{,}249)}{2} = 4{,}215.38$$

$$w_{PR3} = (15.60)(81) = 1{,}263.60$$

If in 2008 the estimates for the surveys were: $\overline{CPUE}_{PR1,2010} = 4.21$, $\overline{CPUE}_{PR2,2010} = 6.28$, and $\overline{B}_{PR3,2010} = 14.70$, the Project Results for Lanuza Bay will be:

$$PR1 = \frac{4.21-3.71}{3.71}\times 100 = 13.62\%$$

$$PR2 = \frac{6.28-6.23}{6.23}\times 100 = 0.87\%$$

$$PR3 = \frac{14.70-12.55}{12.55}\times 100 = 17.14\%$$

$$APR_L = \frac{(13.62)(2{,}185.75)+(0.87)(4{,}215.38)+(17.14)(1{,}263.60)}{2{,}185.75+4{,}215.38+1{,}263.60} = 7.19$$

Tawi-Tawi Bay

$$\overline{CPUE}_{PR1,2004} = \frac{(3.71)(69)+(5.86)(24)+(5.48)(23)}{69+24+23} = 4.51$$

$$\overline{CPUE}_{PR2,2004} = \frac{(55.9)(156)+(29.3)(425)+(15.6)(209)+(19.6)(134)+(29.6)(113)+(3.5)(142)+(5.2)(124)+(37.6)(103)}{156+425+209+134+113+142+124+103} = 25.19$$

$$\overline{B}_{PR3,2004} = \frac{(9.70)(0.20)+(19.88)(0.20)+(25.97)(0.20)}{0.20+0.20+0.20} = 18.52$$

$$w_{PR1} = \frac{(3.50)(265)}{2} = 463.75$$

$$w_{PR2} = \frac{(3.50 + 3.25)(265)}{2} = 894.38$$

$$w_{PR3} = (15.60)(177) = 2{,}761.20$$

If in 2008 the estimates for the surveys were: $\overline{CPUE}_{PR1,2010} = 4.51$, $\overline{CPUE}_{PR2,2010} = 22.17$, and $\overline{B}_{PR3,2010} = 20.67$, the Project Results for Tawi-Tawi Bay will be:

$$PR1 = \frac{4.51 - 4.51}{4.51} \times 100 = 0.00\%$$

$$PR2 = \frac{22.17 - 25.19}{25.19} \times 100 = -12.01\%$$

$$PR3 = \frac{20.67 - 18.52}{18.52} \times 100 = 11.61\%$$

$$APR_T = \frac{(0.00)(463.75) + (-12.01)(894.38) + (11.61)(2{,}761.20)}{463.75 + 894.38 + 2{,}761.20} = 5.18\%$$

4.3 The Intermediate FPR for Monitoring Year 2008

A simulated year 2008 hypothetical set of data is used for the computation process in determining the FPR. It projects some scenario successes and failures in FISH Project's resource management interventions.

$$FPR_{2008} = \frac{(APR_C \cdot w_C) + (APR_D \cdot w_D) + (APR_L \cdot w_L) + (APR_T \cdot w_T)}{w_C + w_D + w_L + w_T}$$

$$FPR_{2008} = \frac{(11.00)(860) + (21.62)(1{,}227) + (7.19)(1{,}330) + (5.18)(442)}{860 + 1{,}227 + 1{,}330 + 442} = 12.40\%$$

This could be interpreted as marine fish stocks to have increased by 12.4% from year 2004 to year 2008 based on fishery-independent surveys, fishery-dependent catch and effort monitoring, and fish biomass MPA fish visual census. Peculiarities like the extent of the hard bottom, soft bottom, coral reefs, type of fisheries (demersal or pelagic), and potential yield were used as weighting factors in averaging and pooling of values.

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